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(54) LAMINATED PIEZOACTUATOR

(57)Abstract:
PURPOSE: To avoid the occurrence of migration by coating the whole surface of a piezoelement with a migration metal as an electrode.
CONSTITUTION: This laminated piezoactuator is composed of multiple piezoelement layers comprising piezoelements 1 of zircon titanate base ceramic pieces. The piece side whole surface is provided with a non-migration electrode 2 coated with a non-migration metal as well as an electrode plate 3 in the same diameter as that of the piezoelement 1 furthermore, positive and negative side electrodes 4, silicon grease 5, an insulating tube 6 and lead wires 7. Al does not increase the current with the time lapse after potential impression different from Ag. Accordingly, Au and Al are the non-migration materials. Thus, the migration can be avoided by using the non-migration metals to form a film on the piezoelement 1.

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CLAIMS

[Claim(s)]
[Claim 1] The laminating mold piezo actuator which is a laminating mold piezo actuator which has an electrode plate (3) in the piezo-electric element (1) of two or more layers, and is characterized by carrying out it with ** all over said electrode plate (3) and the piezo-electric element (1) which counters, using a non-migration metal as an electrode.
[Claim 2] The laminating mold piezo actuator according to claim 1 which carries out said non-migration metal with ** by sputtering.
[Claim 3] The laminating mold piezo actuator according to claim 1 which uses gold, aluminum NYUMU, palladium, platinum, etc. as said non-migration metal.

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] About a laminating mold piezo actuator, especially this invention prevents the migration of an electrode, and its this invention can improve an insulation, and relates to the electrode structure which makes reinforcement

possible.
[0002]
[Description of the Prior Art] There is a laminating mold piezo actuator which makes a mobile drive by telescopic motion of a laminating mold piezoelectric device as a technique of such [conventionally] a field. Drawing 7 is drawing showing the piezo-electric element of the conventional laminating mold piezo actuator. The electrode 102 of the silver (Ag) made into one side of this piezo-electric element 101 with ** and the electrode plate 103 located in the side which intervenes a piezo-electric element 101 and counters said electrode 102 which are one layer in a laminating mold piezo actuator are formed in the piezo-electric element 101 which consists of a ceramic piece of a zircon lead titanate system. Moreover, in order to secure an insulation from the field of the engine performance and dependability, the diameter of an electrode uses the electrode 102 of this piezo-electric element 101 as a small part with ** from the path of a piezo-electric element 101 by the silver paste burning method, and it is formed with the so-called partial electrode. Thus, it generates - high power that it is only serious by a laminating mold piezo actuator's carrying out the laminating of the electrode plate 103 to the PIEZO component 101 which carried out the electrode with ** by turns, and considering as electric juxtaposition and mechanical in-series structure, and it is used for the automobile, the machine tool, etc. as actuators, such as a precision flow control valve as which especially high degree of accuracy and a high response are required.
[0003]
[Problem(s) to be Solved by the Invention] However, when an electrode 102 is carried out with ** as mentioned above, when this laminating mold piezo actuator is driven in the conventional laminating mold piezo actuator, stress is generated in it at the electrode edge with the heterogeneity of the electrode reinforcement inside a piezo-electric element, a crack is induced to it, therefore an insulating fall is invited to it, and there is a problem of it not only falling the property of piezo-electric element original with the stress, but becoming actuation impossible in it. Moreover, insulation fell by the migration of the moisture and silver to which it stuck at the time of a laminating mold piezo actuator drive, operating became impossible, and there was a problem on quality. There are some which were indicated by JP,62-199001,A about this migration. With this conventional technique, in addition to the silver which is a migration ingredient about the palladium (Pd) which is a non-migration ingredient, there is effectiveness which lengthens time amount to generating of MAGURESHON, but there is a problem that it does not become that there is nothing. Moreover, in extent which adds a migration ingredient, in order that a piezo-electric element may use a big electrical potential difference, the effectiveness over a life is smaller than a positive porcelain semi-conductor. In order to form a non-migration metal as an electrode by the paste burning method, it is necessary to use many frits and, for this reason, a piezo-electric property is reduced.

[0004] Therefore, this invention aims at offering the laminating mold piezo actuator which insulation improves in view of the above-mentioned trouble, and can demonstrate the engine performance enough.
[0005]
[Means for Solving the Problem] In order to solve said trouble, this invention is a laminating mold piezo actuator which has an electrode plate in the piezo-electric element of two or more layers, all over said electrode plate and the piezo-electric element which counters, uses a non-migration metal as an electrode, and carries out it with **. Moreover, said non-migration metal is carried out by sputtering with **.
[0006] Furthermore, gold, aluminum NYUMU, palladium, platinum, lead, etc. are used as said non-migration metal.
[0007]
[Function] According to the laminating mold piezo actuator of this invention, by carrying out a non-migration metal to said electrode plate with ** as an electrode all over the piezo-electric element which counters, generating of migration is barred, stress can occur further at the electrode edge by the heterogeneity of the electric field strength inside a piezo-electric element, induction of a crack can be barred, the insulating fall of a laminating mold piezo actuator can be prevented, and the reinforcement can be attained.
[0008] When said non-migration metal is carried out by sputtering with **, the unnecessary loss of the electric field inside an electrode is barred, and actuator properties, such as the amount of displacement and generating force, can be improved.
[0009]
[Example] The example of this invention is explained with reference to a drawing below. Drawing 1 is the perspective view showing the laminating mold piezo actuator concerning the example of this invention, and drawing 2 is the sectional view and a partial diagrammatic view. **. Nothing and its piezo-electric element possess the electrode 2 of the non-migration which was a piezo-electric element 1, used the non-migration metal all over one side of this piezo-electric element 1, and carried out sputtering with ** which consists of a ceramic piece of a zircon lead titanate system, and the electrode plate 3 of said piezo-electric element 1 and diameter of said for the piezo-electric element layer of plurality [actuator / which is shown in this drawing 1 / laminating mold piezo]. Thus, it is made to have not produced the heterogeneity of the electric field strength inside a piezo-electric element by carrying out a non-migration metal with ** all over one side of this piezo-electric element 1. Furthermore, a laminating mold piezo actuator possesses the forward and negative side-face electrode plate 4, the silicon grease 5, an insulating tube 6, and lead wire 7. The plunger 8 which tells outside the variation rate of the laminating mold piezoelectric device which carries out the laminating of the electrode plate 3 to the PIEZO component 1 which made with ** the electrode 2 which becomes the whole surface from a non-migration metal the body of a laminating mold piezo

actuator by turns as shown in this drawing 2 (a), and is made into electric juxtaposition and mechanical in-series structure is formed. The piezo-electric element 1 seen from A-A is shown in this Fig. (b), and the electrode 2 of non-migration seen from B-B is shown in this Fig. (c).

[0010] Drawing 3 is drawing showing the experimental result of migration. When a migration phenomenon gives the potential difference to inter-electrode [of a pair], the silver larer which forms an electrode in a negative electrode says it being transmitted and moving a piezo-electric element 1 from the positive electrode of the electrode of this pair. Although a current will increase to a short time after electrical-potential-difference impression by migration if based on silver (Ag) migration as an example C1 of a comparison as shown in this Fig., aluminum NYUMU (aluminum) follows on gold (Au) as Example 1, follows that applied voltage is large on the time amount progress after electrical-potential-difference impression as Example 2, and a current does not increase like silver. Therefore, it turns out that gold (Au) and aluminum NYUMU (aluminum) are non-migration material. In addition, as a metal for electrodes, although there are palladium (Pd), platinum (Pt), nickel (nickel), lead (Pb), etc., as a non-migration metal, there are palladium (Pd) except nickel (nickel), platinum (Pt), lead (Pb), etc. Therefore, by forming membranes on a piezo-electric element 1 using a non-migration metal, the migration of the moisture and electrode metal to which it stuck like before at the time of the drive of a laminating mold piezo actuator can be prevented, the insulating fall by the migration of a laminating mold piezo actuator can be prevented, and there is effectiveness which makes reinforcement of a product possible.

[0011] Membrane formation to a piezo-electric element 1 is performed by not membrane formation but sputtering to the piezo-electric element 1 by the metal paste burning method of the former [material / these / non-migration]. This is based on the following reason. In addition, since sputtering is a well-known technique, it omits explanation of itself. Drawing 4 explains the membrane formation to the piezo-electric element by sputtering. The equal circuit of the piezo-electric element 101 which has the electrode 101 formed by the conventional metal paste baking is shown in this Fig. (a), and a piezo-electric element 101 has an electrical-potential-difference loss with the dielectric constant of the flicker component of the metal paste baking electrode 102. In this case, it is supply voltage V0 It is VP about the electrical potential difference which carries out and is impressed to a piezo-electric element 101. It carries out. the electrical potential difference impressed to a piezo-electric element 1 although the equal circuit of the piezo-electric element 1 which has the electrode 2 formed by metal sputtering is shown in this Fig. (b) -- VS ** -- if it carries out -- VS **V0 it is . Therefore, VS >VP It is materialized. In order to form membranes in the conventional method of metal paste baking, many frits, such as a glass component, are contained, this works as a dielectric, and since this does not have the loss of the electric field inside the electrode by the frit, it is effective in raising actuator properties, such as the amount of displacement, and

generating force, in order to form an electrode only with a metal, when the electrode which formed membranes by sputtering is used to there being a loss of an electrical potential difference inside. Sputtering of a concrete non-migration metal is explained below.

[0012] Drawing 5 is drawing showing the concrete property of the laminating mold piezo actuator concerning this example. As for the gold (Au) which is non-migration material first, aluminum NYUMU (aluminum), palladium (Pd), platinum (Pt), lead (Pb), etc., it is desirable to form membranes by 0.5-2-micrometer thickness on a piezo-electric element 1. In 0.5 micrometers or less, the property (variation rate amount) as an actuator is small, and it is for the amount of displacement to begin to fall in 2 micrometers or more. When membrane formation of an electrode material is performed in the 10A/second - 100A [/second] range, since an equivalent property is acquired, it considers as 1-micrometer membrane formation in a second in 20A /. And membranes are formed like the above to the piezo-electric element 1 of 16mm (phi) of diameters, and 0.385mm of thickness (t), and it is the stack of 56 sheets which carried out the laminating. - The amount of displacement when impressing the electrical potential difference of 200-600V and the generating force are acquired as a property of a laminating mold piezo actuator, as shown in drawing 5 . In this drawing 5 , the example C1 of a comparison is the property of the silver (Ag) from the former, and Examples 1, 2, 3, 4, and 5 are the properties of gold (Au), aluminum NYUMU (aluminum), palladium (Pd), platinum (Pt), and lead (Pb), respectively. As shown in this drawing 5 , except for aluminum NYUMU (aluminum), the property is improving greatly from gold (Au), palladium (Pd), platinum (Pt), and lead (Pb) as compared with silver (Ag). Therefore, it is effective in improving the amount of displacement, and an output sharply depending on the non-migration metal to choose.

[0013] Drawing 6 is drawing showing the mean down time (MTTF) of the laminating mold piezo actuator concerning this example. The silver (Ag) of the example C1 of a comparison which is migration material as shown in this drawing 6 is 31x105. Migration does not occur but the gold (Au) which is non-migration although it breaks down by the count of actuation, aluminum NYUMU (aluminum), palladium (Pd), and platinum (Pt) are 3x108. Failure is not seen in the count of actuation. However, the lead (Pb) which is non-migration is 20x103. Since it breaks down by the count of actuation, it excepts.

[0014]

[Effect of the Invention] Since it was carried out with ** all over the electrode plate and the piezo-electric element which counters according to this invention, having used the non-migration metal as the electrode as explained above, generating of migration is barred, stress can occur further at the electrode edge by the heterogeneity of the electric field strength inside a piezo-electric element, induction of a crack can be barred, the insulating fall of a laminating mold piezo actuator can be prevented, and the reinforcement can be attained. since a non-migration metal is

furthermore carried out with ** by sputtering -- the unnecessary loss of the electric field inside an electrode -- barring -- a variation rate -- actuator properties, such as an amount and generating force, -- it can improve -- the engine performance and dependability -- improving .

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]

[Drawing 1] It is the perspective view showing the laminating mold piezo actuator concerning the example of this invention.

[Drawing 2] It is the sectional view and partial diagrammatic view of a laminating piezo actuator concerning the example of this invention.

[Drawing 3] It is drawing showing the experimental result of migration.

[Drawing 4] It is drawing explaining the membrane formation to the piezo-electric element by sputtering.

[Drawing 5] It is drawing showing the concrete property of the laminating mold piezo actuator concerning this example.

[Drawing 6] It is drawing showing the mean down time (MTTF) of the laminating mold piezo actuator concerning this example.

[Drawing 7] It is drawing showing the piezo-electric element of the conventional laminating mold piezo actuator.

[Description of Notations]

1 -- Piezo-electric element
2 -- Electrode of a non-migration metal
3 -- Electrode plate
4 -- Forward and negative side side electrode plate
5 -- Silicon grease
6 -- Insulating tube
7 -- Lead wire